



Payload Operations Integration Working
Group (POIWG)
22 July 2015

**Human Research Program
(HRP)**

Susan Hanley

HRP Increment 45/46 Overview



Increment Manager
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Increment Lead
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AGENDA

- **HRP Experiments**
 - Continuation of One Year Mission
 - HRP Inc 45/46 Complement
 - New HRP In-flight Experiments – Dose Tracker
- **Other In-Flight Activities**
 - Facility Activities
 - Support to/from Other NASA Partners and International Partners
- **Challenges**
- **Open Work**
- **Backup Charts: Investigation Summaries**



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CONTINUATION OF ONE YEAR MISSION (1YM)

Science Program with Russian colleagues

- Joint Study: US and Russian PI's
 - Fluid Shifts with Ops in the USOS and Russian Segment
 - Field Test (Pre/Post Only)
- Cross-participation: Both US and Russian 1YM crewmembers participate in the same studies
 - Two Russian Studies:
 - Interactions-2 – Sociomapping questionnaire and Personal Self-Perception and Attitudes (PSPA) application
 - Pilot-T – Flight Simulator study
 - Five US Studies:
 - Cognition, Fine Motor Skills, Ocular Health, Reaction Self Test, Sleep



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HRP Inc 45/46 Complement

In-Flight Experiments

- Biochemical Profile
- Bisphosphonates (Control)
- Body Measures
- Cardio Ox
- Cognition
- **Dose Tracker** (New, reserve)
- Fine Motor Skills
- Fluid Shifts
- Habitability
- Journals (42S US final)
- Microbiome
- NeuroMapping
- Ocular Health
- Reaction Self Test

Previous Increments

37/38 – 43/44
 31/32 – 43/44
 37/38 – 43/44
 37/38 – 43/44
 41/42 - 43/44
 43/44
 43/44
 43/44
 29/30 – 43/44
 35/36 – 43/44
 41/42-43/44
 35/36 – 43/44
 21/22 – 37/38, 43/44



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HRP Inc 45/46 Complement - cont.

In-Flight Experiments

- Repository
- Salivary Markers
- Sleep
- Sprint (Active)
- Sprint (Control)
- Telomeres
- Twins Study

Previous Increments

16-43/44
37/38 – 43/44
25/26 and earlier, 43/44
27/28 – 43/44
27/28 – 43/44
43/44 (Final Subject)
43/44

Pre/Post Only Experiments

- Field Test
- Functional Task Test (FTT)
- Hip QCT

Previous Increments

43/44
21/22 – 37/38, 43/44
27/28 – 37/38, 43/44



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Participation Matrix for HRP Experiments (In-flight)

Experiment	43S US	43S JAXA	42/44S US	42/44S RS	45S US	45S ESA
Biochem Profile	FD60, R-14	FD60, R-14	FD 180, 240, 300, 360, R-14			FD15, 30, 60
Bisphosphonates (Control – shared with Cardio Ox)	FD60, R-14					
Body Measures	FD80, R-15					
Cardio Ox	FD60, R-14		FD180, 240, 300, R-15		FD15, 60	FD15, 60
Cognition	FD65, FD84, FD103, FD122, FD141, R-10	FD65, FD84, FD103, FD122, FD141, R-10	FD180, FD206, FD 233, FD 263, FD 300, R-14	FD180, FD206, FD 233, FD 263, FD 300, R-14	FD6, FD13, FD20, FD27, FD46, FD65	FD6, FD13, FD20, FD27, FD46, FD65
Dose Tracker (NEW)					<i>FD7, every 6-8 days</i>	<i>FD7, every 6-8 days</i>
Fine Motor Skills			Every 2 weeks until R-7 (13 sessions)	Every 2 weeks until R-7 (13 sessions)	FD2, 5, every 5 days for 17 sessions	FD2, 5, every 5 days for 17 sessions
Fluid Shifts			FD150*, R-45	FD150*, R-45		

Unbold Italics = Reserve session

**Chibis ops only; all other FD150 activities in I44*



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Participation Matrix for HRP Experiments (In-flight) – cont.

Experiment	43S US	43S JAXA	42/44S US	42/44S RS	45S US	45S ESA
Habitability			FD175, R-45; weekly tasks; monthly tasks		<i>FD30, weekly tasks; monthly tasks</i>	<i>FD30, weekly tasks; monthly tasks</i>
Journals			3x / wk			
Microbiome	FD90, R-14, R-1 (43S Return, ambient)	FD90, R-14, R-1 (43S Return, ambient)	FD180, R-14, R-1		<i>FD7</i>	
NeuroMapping		FD90, FD 150	FD210, 270, 330		FD30	
Ocular Health	FD90 , 120, R-30	FD90 , 120, R-30	FD210, 270, R- 30	FD210, 270, R- 30	FD10, 30, 60	FD10, 30, 60
Reaction Self Test			Tests every 10d 1 EVA & 1 <i>Sleep Shift</i>	Tests every 10d 1 EVA & 1 Sleep Shift		
Repository	FD60, 120, R-14	FD60, 120, R-14			FD15, 30, 60	FD15, 30, 60
Salivary Markers		R-1 43S Return (Ambient)	FD214, R-1 43S & 44S Return (Ambient)		FD10 (Frozen), 43S Return (Ambient)	

Bold = Med Ops session, *Unbold Italics* = Reserve session



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Participation Matrix for HRP Experiments (In-flight) – cont.

Experiment	43S US	43S JAXA	42/44S US	42/44S RS	45S US	45S ESA
Sleep			Wear watches, monthly downloads, 5 weeks of sleep log	Wear watches, monthly downloads, 5 weeks of sleep log		
Sprint		USND: <i>FD60</i> , R-7 VO2: <i>FD75</i> , R-30	USND: 180, 240, 300, R-7 VO2: 165, 225, 285, R-30			
Telomeres	R-1 43S Return (Ambient)		FD 214 43S Return (Ambient)			
Twins Study			FD180 Flu Shot; 191;43S & 44S Return (Ambient)			

Italics = Reserve session



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New Experiment: Dose Tracker

PRINCIPAL INVESTIGATOR

- Virginia Wotring, Ph.D., NASA/JSC

RESEARCH OBJECTIVES

- To develop and employ an iOS application (app) for the collection of medication usage data from crewmember participants during their missions. This data will suggest whether in-flight pharmacokinetic changes (alterations in how the body absorbs, distributes, metabolizes or excretes a medication), in-flight pharmacodynamic changes (alterations in how the medication interacts with target molecules and biochemical pathways), or unusual side effects occur during flight (frequency or quality). Subjects will use the application pre-flight to collect ground medication usage data as a basis for comparing medication usage and effects in the same individuals.

IN-FLIGHT OPERATIONS

- Dose Tracker app will be available with the Espresso Service Pack due for release in November.
- Each in-flight data collection session will require 15 minutes to complete the Dose Tracker application on the iPad. Subject will enter medication usage data from previous week into the Dose Tracker App. The first in-flight session should be on FD 7 (+1) and at a minimum, every 6-8 days thereafter.



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HRP Inc 45/46 Facility Activities

- **HRF Supply Kit Inventory & Resupply**
- Ultrasound Configuration Maintenance (reserve)
- GDS/PFS Gauge Photos (may move to I44; reserve for I45/46)
- PFS GMS Calibration may move to I44; reserve for I45/46)
- PFS Relief Valve Checkout may move to I44; reserve for I45/46)
- R2 RFID/8PU & Purple Pantry Drawer content swap (dependent on manifesting RFID drawer; reserve)

HRP Support to Other NASA Parties

- Med Ops Ocular Ultrasound Scanning
- Rodent Research uses HRF Centrifuge





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HRP Inc 45/46 Support to IP Science

CSA

- **BP Reg** – Uses HRF PFS and CBPD
- **Vascular Echo** – Uses HRF blood collection supplies, Centrifuge and Ultrasound
- **MARES Commissioning Part 2** – Uses HRF Ultrasound and PEMS2

ESA

- **Airway Monitoring** – Uses HRF PuFF Calibration Syringe
- **Energy** – Uses HRF PFS

JAXA

- **Biological Rhythms 48** – Uses Actiwatch Reader & Cable



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HRP Inc 45/46 Use of IP Hardware

ESA HW

- **Sprint** – Portable Pulmonary Function System (PPFS)
- **Fluid Shifts & Cardio Ox** – CDL HLTA BP device
- **NeuroMapping** – Game Pad

Russian HW

- **Fluid Shifts:**
 - Chibis Lower Body Negative Pressure system
 - GAMMA medical monitoring system



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HRP Inc 45/46 Challenges

- Continuing HRP Inc. 43/44 Challenges
 - Continuing 1YM experiments
 - Two complex studies with multi-day sessions
 - Ocular Health and Fluid Shifts
- Multiple experiments/subjects/sessions below the line
 - Fluid Shifts FD150 Chibis ops is moving from I44 to I45 as well
- Blood Volume Limits
 - Very tight plan that will require careful management

Timeline changes affect blood volume calculations and could impact science



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HRP Inc 45/46 Challenges (Continued)

- **SpaceX-7 Mishap Impacts**
 - Working to re-manifest lost HRP hardware; on-orbit supplies sufficient through December assuming additional Twins Study blood tubes and Urine Collection Kits get added to 61P and HTV5
 - Cold Stowage & downstream resupply threat with unknown SpaceX return to flight date
- **43S – 45S Direct Handover Scheduling Impacts**
 - Microbiome and Salivary Markers ambient blood draws for 3 crew
 - Microbiome water sample collection
 - Loss of water sampling hardware and return on SpaceX-7 will result in loss of science for the 43S crew unless the session can be recovered in this timeframe and this sample will cover both the 43S & 45S crew. Water sampling hardware is manifested on Orb-4,
 - FD270 Ocular Health for 1YM crew
 - FD7/10 for 45S crew

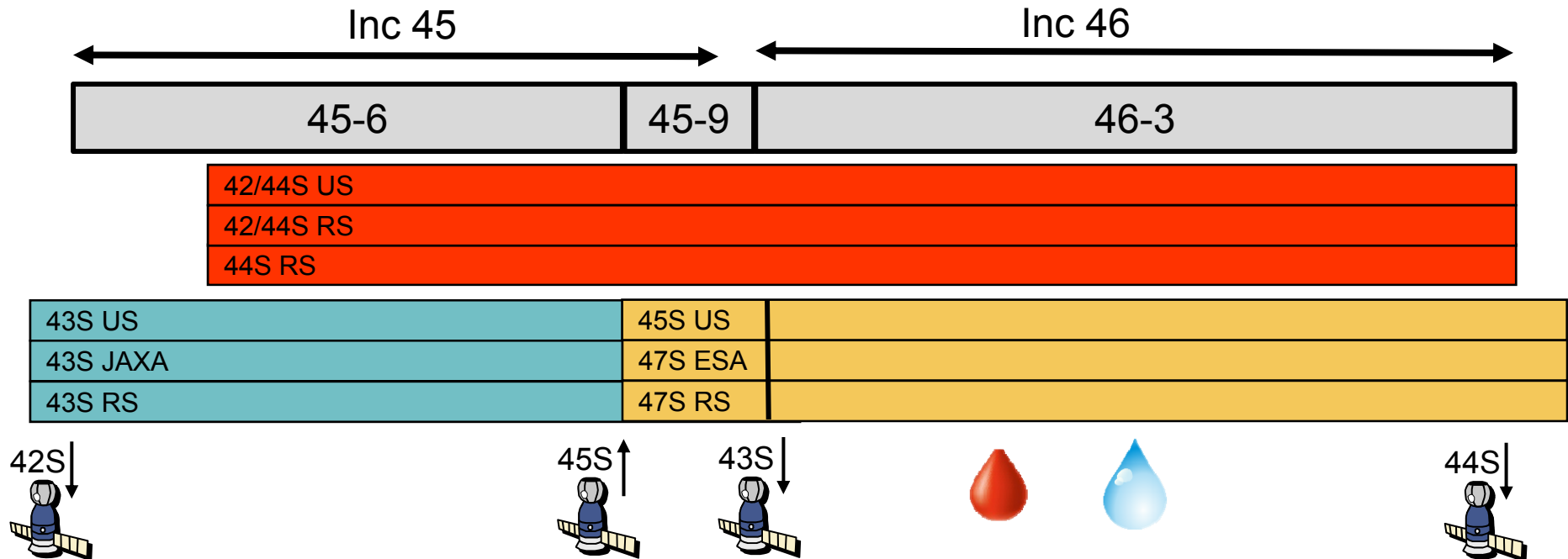


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HRP Ambient Sample Returns



- Ambient 43S US & JAXA blood return for Salivary Markers, Telomeres and Microbiome R-1 plus 42/44S US Telomeres and Twins Study blood on 43S descent
- Ambient 45S US blood return possible for Salivary Markers and Microbiome Mid-session plus 42/44S US Telomeres and Twins Study blood on 44S descent . Currently this subject is reserve for Inc. 45/46.
- Carries a 48 hours return requirement so a contingency sample return logistics plan would be required



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Additional Med Ops Eye Exams

- Med Ops Eye Exams require HRF Rack 1 activation and Ultrasound support
- VIIP protocol requires FD30, FD90 and R-30 on both USOS and RSOS crew

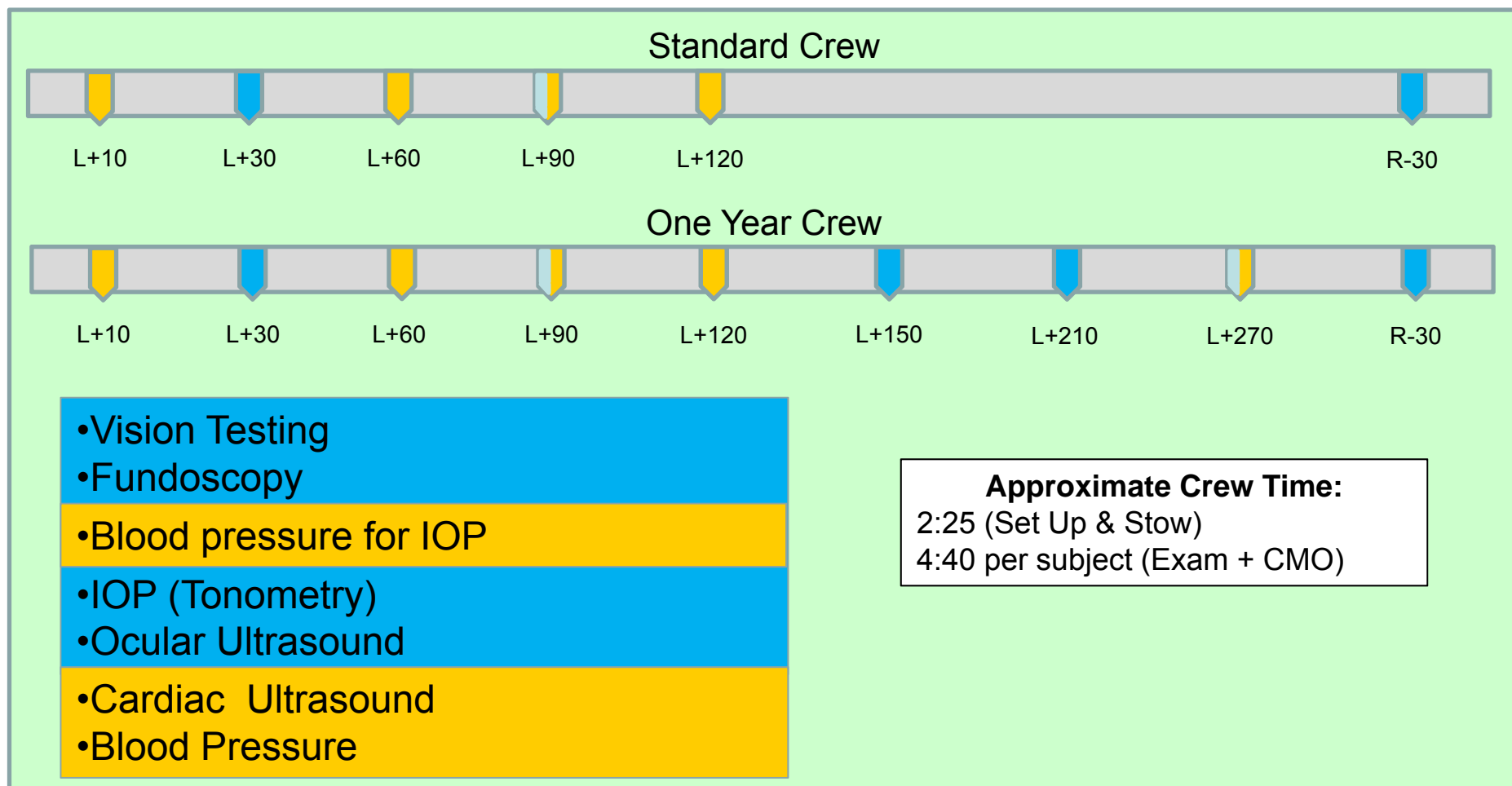


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Eye Exam Chart



MedB Requirement

Ocular Health Requirement

Currently assuming full Russian participation.

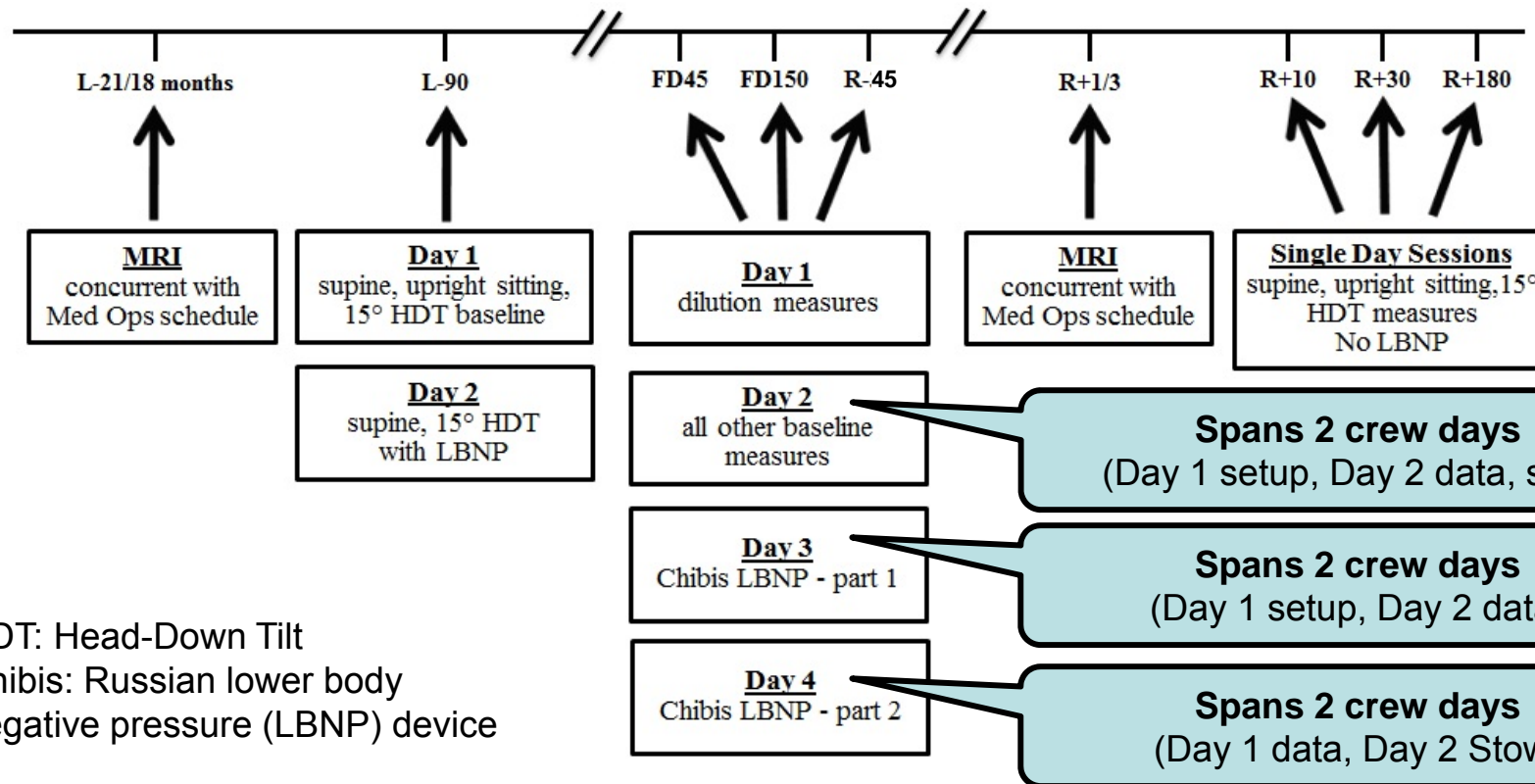


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Fluid Shifts Overview



HDT: Head-Down Tilt
Chibis: Russian lower body
negative pressure (LBNP) device



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Questions?



HRF Ops Team in the TeleScience Support Center within MCC-Houston.



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Back Up Slides



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Pre/Post Only Participation Matrix

Experiment	43S US	43S JAXA	42/44S US	42/44S RS	45S US	45S ESA
Field Test (new)		✓	✓**	✓		
Functional Task Test * Pilot Field Test only			✓**			
Hip QCT			✓			

* Subset of FTT at landing site / airport / crew quarters called “Pilot Field Test”
or “FTT Bridge to Field Test”

** Crewmember will complete full protocol for both studies. Will share data and not duplicate any tests.



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Pre-/Post- Investigation Summaries

Field Test (new):

NASA PI: Millard F. Reschke, Ph.D.

Brief Research Summary: The Field Test is made up of studies designed by the Neuroscience and Cardiovascular Laboratories at NASA's Johnson Space Center and the Institute of Biomedical Problems, Moscow, Russia to investigate changes in human physiology that affect returning astronauts and cosmonauts following space flight missions lasting from six months to one year. Changes in vision, balance, coordination, blood pressure and even the ability to walk have a substantial impact on the way very basic and fundamental tasks are performed. The Field Test experiment is designed to measure the complexity, magnitude, duration and recovery of these changes in order to better understand the kind of treatment that is necessary to speed-up recovery and prevent injury to our astronauts.

Data Collection:

- Three pre-flight sessions and garment measuring
- Three landing day sessions – at approximately 2 - 5 hours, 10 hours, and 24 hours after landing
- Five post-flight sessions – 1, 4, 6, 15 and 30 days after landing



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Pre-/Post- Investigation Summaries

Functional Task Test:

NASA PI: Jacob Bloomberg, Ph.D.

Brief Research Summary: The primary objective of the Functional Task Test (FTT) project is to develop and evaluate an integrated set of functional and physiological tests, and then use those tests to determine how post flight changes in sensorimotor, cardiovascular, and muscle physiology impact functional performance (e.g. standing, ladder climbing, and hatch opening).

Data Collection:

- Three pre-flight sessions – L-180, L-60, L-30
- Three post-flight sessions – R+1, R+6, and R+30



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Pre-/Post- Investigation Summaries

Hip QCT:

Jean Sibonga, Ph.D. & Thomas Lang, Ph.D.

Brief Research Summary: The primary objective of Hip QCT is to monitor changes in hip sub-regions in response to in-flight countermeasures (CM). This QCT study will also demonstrate how countermeasures that involve mechanical loading of the hip (e.g., exercise) could be distinguished from CMs that involve biochemical suppression of bone resorption (e.g., bisphosphonates) because these two categories of CMs affect different bone compartments of the hip (anti-resorptives on trabecular bone, exercise on cortical bone). Finally, QCT will enable hip strength estimations by Finite Element [FE] Modeling – which detects more changes in hip strength due to space than with DXA modality.

Data Collection: Pre-/Post-flight testing only; involves QCT assessment.



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In-Flight Investigation Summaries

Continuing Studies

Additional information for
Fluid Shifts and Twins Study



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Investigation Summaries

Biochemical Profile:

Scott M. Smith, Ph.D.

Brief Research Summary: Blood and urine are commonly used to assess an astronaut's health as well as conduct research in physiological disciplines by measuring key biomarkers found in these fluids. In support of research studies, this project will collect, process and store blood and urine samples obtained during the preflight, in-flight and postflight phases of ISS missions and maintain a database of results from the analysis of these samples. This database will offer supporting evidence to scientists by providing metabolic profiles of the effects of spaceflight on human physiology.

In-Flight Data Collection: 24-hour urine collection, blood draw and subsequent processing.



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Investigation Summaries

Bisphosphonates (Control): Adrian Leblanc, Ph.D. & Toshio Matsumoto, Ph.D.

Brief Research Summary: Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss. The purpose of the Bisphosphonates study is to determine whether an antiresorptive agent, in conjunction with the routine in-flight exercise program, protects International Space Station (ISS) crewmembers from the regional decreases in bone mineral density documented on previous ISS missions.

Control subjects will not ingest the bisphosphonate pill in order to provide a comparison.

In-Flight Data Collection: 24-h Urine collection, Diet/Exercise Logs



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Investigation Summaries

Body Measures:

Sudhakar Rajulu, Ph.D.

Brief Research Summary: Currently, NASA does not have sufficient in-flight anthropometric data (body measurements) gathered to assess the impact of physical body shape and size changes on suit sizing. This study will involve collecting anthropometric data (body measurements) using digital still and video imagery and a tape measure to measure segmental length, height, depth, and circumference data for all body segments (i.e., chest, waist, hip, arms, legs, etc.) from astronauts for pre-, post-, and in-flight conditions.

In-Flight Data Collection: Circumference measurements with a tape measure along with photographic and video imagery.



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Investigation Summaries

Cardio Ox:

Steven H. Platts, Ph.D.

Brief Research Summary: Future human space travel missions may increase the risk of oxidative and inflammatory damage primarily from radiation, but also from psychological stress, reduced physical activity, diminished nutritional standards and exposure to altered oxygen levels during extravehicular activity. There is evidence that higher levels of oxidative and inflammatory stress and associated damage to blood vessels contribute to cardiovascular disease. The purpose of this study is to measure levels of biomarkers in blood and urine that are affected by oxidative and inflammatory stress before, during, and after long duration spaceflight and relate them to the risk of developing atherosclerosis.

In-Flight Data Collection: Ultrasound scans (carotid/brachial) with ECG recording, blood draw and 24-h Urine collection.



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Investigation Summaries

Cognition:

Mathias Basner, Ph.D., M.D., MSc

Brief Research Summary: Given the breadth of neurocognitive functions required for effective performance in space, the need to medically manage sleep and fatigue in space, the very limited neurocognitive assessment tools currently in space flight, and the often anecdotal nature of cognitive complaints from space flight, there is a critical need for rapid objective assessment of a range of neurocognitive performance functions in space flight. This project will achieve this goal by developing a much-needed practical, yet comprehensive cognitive test battery, validating its sensitivity to fatigue and fatigue countermeasures, determining astronaut norms for the test battery, and establishing space-flight feasibility of the battery.

In-Flight Data Collection: Cognition consists of 10 brief cognitive tests, each 1-3 minutes in length. The tests will be performed 11 times in-flight. Crewmembers will perform tests on the following days: 4 times early in-flight with a 1-week interval (FD 6, 13, 20, 27), 7 times later in-flight at 19-day intervals (FD 46, 65, 84, 103, 122, 141, 160).



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Fluid Shifts

IN-FLIGHT MEASUREMENTS & HARDWARE

Intracranial Pressure

- **Cerebral and Cochlear Fluid Pressure (CCFP)**
- **Distortion Product Otoacoustic Emissions (DPOAE)** and **earmuffs**



Ocular Structure, Pressure, Vision

- Optical Coherence Tomography (OCT)
- Tonometry, Ultrasound, Data Sharing w/ Med Ops

Ultrasound measures of fluid shifts (**new cable** for RS)

- Arterial and venous measures of head and neck
- Cardiac, ophthalmic, and portal vein measures
- Tissue thickness of lower and upper body
- **Manometer:** Used for Mueller maneuvers with Ultrasound



Other physiological measures

- Blood Pressure with **ESA CDL HLTA BP device**
- Heart Rate with ECG in Ultrasound

Note: Bold shows new hardware



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Fluid Shifts – cont.

IN-FLIGHT MEASUREMENTS & HARDWARE – cont.

Fluid compartmentalization

- Existing Sample collection Hardware; **Tracer kit and syringe**
 - Assessment of total body water (via saliva /urine analysis) and extracellular and intracellular fluid volume (via blood/urine analysis).

Imaging Tests with Lower Body Negative Pressure

- In Russian Segment (RS) with Hardware on previous page (not ESA CDL HLTA BP device) and **new USND cable** for use in RS
- Russian Hardware:
 - Chibis - generate lower body negative pressure
 - GAMMA system - medical monitoring device; provides BP and ECG

IN-FLIGHT OPERATIONS: Sessions on FD45, 150, & R-45 each with

Dilution Measures (1 day)

Baseline Imaging Measures (2 days)

Imaging Measures in Chibis (4 days)



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Fluid Shifts – cont.

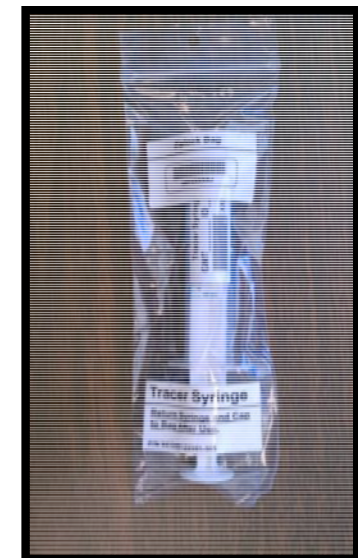
Dilution Measures

Spin blood; freeze all types of samples in MELFI

- Baseline Blood, Urine, and Saliva collected after crew wake
- NaBr tracer ingested (Return empty syringe)
 - Blood sample: 3 hrs after tracer
 - Saliva samples: 3 & 5 hrs after tracer
 - Urine samples void-by-void: through 7 hrs after tracer
- Galley Water sample on same day



Tracer Kit



Tracer Syringe



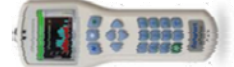
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Fluid Shifts – cont.

Baseline Imaging Measures

- Setup (previous day)
- Data Collection & Hardware Stow
 - USND: Self scan with Remote Guider & Operator (USND keyboard)
 - Locations scanned: Eye (orbit/globe), Head (forehead tissue thickness, temple, base of skull), Neck (carotid artery, vertebral, jugular, and subclavian veins), Heart, Abdomen (portal vein), Leg (shin and ankle tissue thickness)
 - **Manometer** used for Mueller Maneuvers (reverse Valsalva) 
 - OCT: Operator & Remote Guider
 - Tonometry: Operator & Remote Guider
 - **CCFP**: Self scan
 - **DPOAE**: Self scan
 - Requires use of **earmuffs** to attenuate ambient noise
 - **ESA CDL HLTA BP device** (USOS): Subject-initiated with Remote Guider coordination





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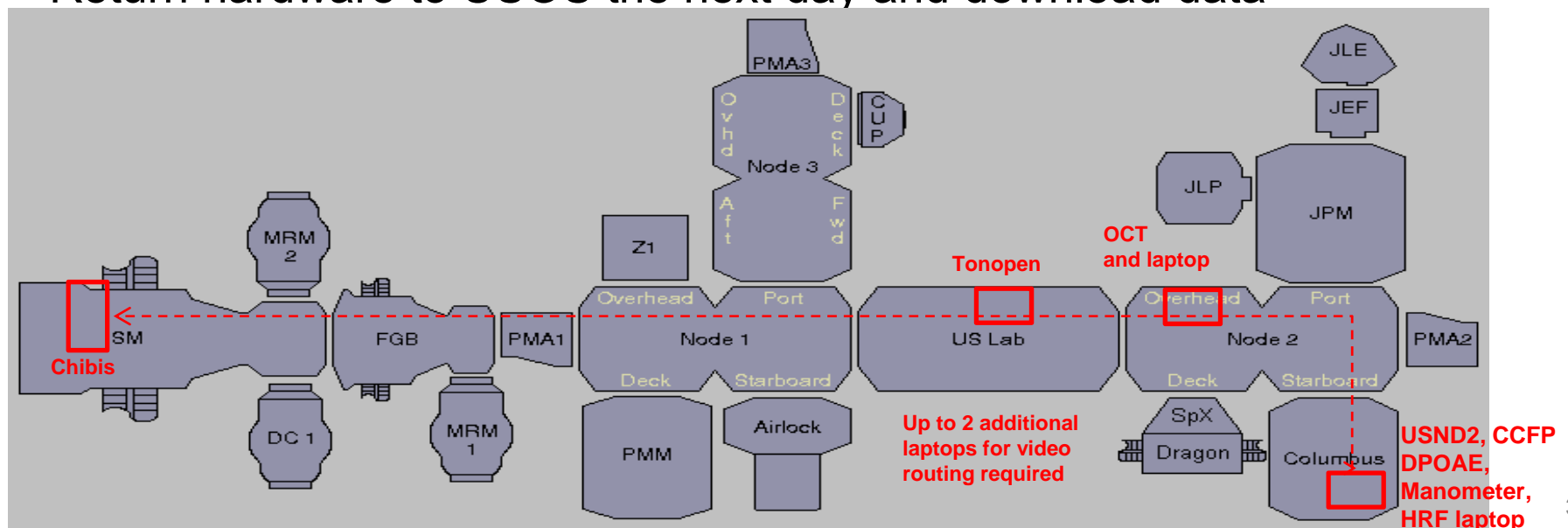
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Fluid Shifts – cont.

Imaging Measures in Chibis.

Repeat all baseline imaging measures possible while wearing Chibis (e.g., no leg USND)
Requires Subject, Operator, and Russian medical monitor. Max 60 min in Chibis/day.

- Move hardware to RS on previous day
- Day 1 Testing: USND data collection with Manometer
- Day 2 Testing: OCT, Tonometer, CCFP (with HRF PC), and DPOAE
- Return hardware to USOS the next day and download data





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Investigation Summaries

Journals:

Jack Stuster, Ph.D.

Brief Research Summary: This study converts behavioral and human factors information contained in confidential journal entries into quantitative data concerning the importance of the various behavioral issues involved in extended-duration space exploration.

In-Flight Data Collection: Periodic journal entries



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Investigation Summaries

Microbiome:

Hernan Lorenzi, M.D.

Brief Research Summary: The Microbiome experiment investigates changes to astronauts' immune systems and microbiomes (the collection of microbes that live in and on the human body). These changes can be detected by taking periodic samples from different parts of the body and the surrounding International Space Station (ISS) environment. As part of this study, the likelihood and consequences of alterations in the microbiome due to extreme environments, and the related human health risk, will be assessed.

In-Flight Data Collection: Blood, Saliva, Perspiration, Potable water collections; Microbiome (body swab), ISS Surface, and optional Gastrointestinal sampling.



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Investigation Summaries

NeuroMapping:

Rachael Seidler, Ph.D.

Brief Research Summary: This research is being conducted to identify if there are any changes in brain structure, function, and network integrity as well as human motor control, spatial processing and multi-task performance abilities as a function of long-duration spaceflight. It will also determine how long it would take for the human body / brain to recover from such adaptations. This research will help generate relationships between structural and functional brain changes, correlated to human performance over time.

In-Flight Data Collection: Subset of behavioral assessment tests will be performed including a mental rotation test, dual task test, and a joystick-based sensorimotor adaptation test. Three (3) in-flight sessions are required on FDs 30, 90, and 150 (flexibility +/- 10 days). Each in-flight session will require 50 minutes of crew time. In-flight sessions will utilize the existing HRF PCs and ESA's universal serial bus (USB) joystick.



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Investigation Summaries

Ocular Health:

Christian Otto, M.D.

Brief Research Summary: The International Space Station (ISS) Ocular Health Protocol aims to systematically gather physiological data to characterize the Risk of Microgravity-Induced Visual Impairment/Intracranial Pressure on crewmembers assigned to a 6 month ISS increment. The data collected will mirror Medical Requirements Integration Documents (MRID) requirements and testing performed during annual medical exams with an increase in the frequency of in-flight and post flight testing to more accurately assess changes that occur in the visual, vascular, and central nervous systems upon exposure to microgravity and the resulting fluid shifts. Monitoring in-flight changes, in addition to post flight recovery, is the main focus of this protocol.

In-Flight Data Collection: Fundoscopy, Tonometry, Visual Testing, Ocular Ultrasound, BP and Vascular Compliance (cardiac ultrasound, BP, EKG)



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Investigation Summaries

Reaction Self Test:

David F. Dinges, Ph.D.

Brief Research Summary: The Psychomotor Vigilance Self Test on the International Space Station is a portable 5-minute reaction time task that will allow the crewmembers to monitor the daily effects of fatigue on performance while on board the International Space Station.

In-Flight Data Collection: Testing using reaction feedback software, scheduled on specific days and sleep shifted schedules, and around EVAs.



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Repository:

Kathleen A. McMonigal, M.D.

Brief Research Summary: The NASA Biological Specimen Repository is a storage bank that is used to maintain biological specimens over extended periods of time and under well-controlled conditions. This repository supports scientific discovery that contributes to our fundamental knowledge in the area of human physiological changes and adaptation to a microgravity environment and provides unique opportunities to study longitudinal changes in human physiology spanning many missions. Samples from the International Space Station (ISS), including blood and urine, are collected, processed and archived during the preflight, in-flight and postflight phases of ISS missions. This investigation archives biosamples for use as a resource for future space flight related research.

In-Flight Data Collection: 24-hour urine collection, blood draw and subsequent processing.



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Salivary Markers:

Richard J. Simpson, Ph.D.

Brief Research Summary: The Salivary Markers investigation involves the collection of blood, saliva, urine and a health assessment on six subjects pre-, in- and post-flight to determine if spaceflight induced immune system dysregulation increases infection susceptibility or poses a significant health risk to crewmembers onboard the International Space Station. The investigation utilizes a longitudinal, repeated measures design to determine the effects of long-term exposure to microgravity on a host of salivary antimicrobial proteins (AMPs), latent viral reactivation, antibacterial properties of saliva, and blood markers associated with innate host immune defense.

In-Flight Data Collection: Blood draw, Saliva sampling, 24-hour urine collection, and Health Assessment using Med Ops' Data Collection Tool (DCT). FD 90 and R-1 blood samples will return ambient on Soyuz



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Investigation Summaries

Sprint (Active and Control):

Lori Ploutz-Snyder, Ph.D.

Brief Research Summary: The Sprint experiment evaluates the efficacy of exercise countermeasures; this includes detailed measurements of cardiovascular and muscle function and bone health and evaluates the effectiveness of a new exercise prescription integrating both resistance and aerobic training exercise.

Control subjects will follow the standard ISS exercise protocol and share exercise data with the Sprint Principal Investigator.

Data Collection: Pre-/Post-flight testing: involves DXA, QCT, MRI, Muscle Performance and Isokinetic testing. Muscle biopsies are optional. In-flight testing for Active subject: Sprint exercise protocol. In-flight testing for Active subjects and added to Control subjects beginning Inc 39/40: VO2 Max and Ultrasound muscle volume scan.



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Twins Study – Principal Investigators

- Susan Bailey, Colorado State University, Differential effects on telomeres and telomerase in twin astronauts associated with spaceflight
- Andrew Feinberg, Johns Hopkins University School of Medicine, Comprehensive whole genome analysis of differential epigenetic effects of space travel on monozygotic twins
- Christopher Mason, Weill Medical College of Cornell University, The Landscape of DNA and RNA Methylation Before, During, and After Human Space Travel
- Scott Smith, NASA Johnson Space Center, Biochemical Profile: Homozygous Twin control for a 12 month Space Flight Exposure
- Emmanuel Mignot, Stanford University School of Medicine, HERO Twin Astronaut Study Consortium (TASC): Immunome Changes in Space
- Fred Turek, Northwestern University, HERO Twin Astronaut Study Consortium (TASC) Project: Metagenomic Sequencing of the Bacteriome in GI Tract of Twin Astronauts
- Stuart Lee, Wyle Laboratories, Metabolomic And Genomic Markers Of Atherosclerosis As Related To Oxidative Stress, Inflammation, And Vascular Function In Twin Astronauts
- Brinda Rana, University of California, Proteomic Assessment of Fluid Shifts and Association with Visual Impairment and Intracranial Pressure in Twin Astronauts
- Mathias Basner, University of Pennsylvania School of Medicine, HERO Twin Astronaut Study Consortium (TASC) Project: Cognition on Monozygotic Twin on Earth
- Michael Snyder, Stanford University, HERO Twin Astronaut Study Consortium (TASC) Project: Longitudinal integrated multi-omics analysis of the biomolecular effects of space travel



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Twins Study – cont.

Short Name	PI	Organization	Long Name
Biochemical Profile	Smith, Scott	NASA/JSC	Biochemical Profile: Homozygous Twin Control for a 12 month Space Flight Exposure
Cognition	Basner, Mathias	University of Pennsylvania	HERO Twin Astronaut Study Consortium (TASC) Project: Cognition on Monozygotic Twin on Earth
Telomeres	Bailey, Susan	Colorado State	Differential Effects on Telomeres and Telomerase in Twin Astronauts Associated with Spaceflight
Twins	Feinberg, Andrew	Johns Hopkins University School of Medicine	Comprehensive Whole Genome Analysis of Differential Epigenetic Effects of Space Travel on Monozygotic Twins
	Lee, Stuart	NASA/JSC (Wyle)	Metabolomic and Genomic Markers of Atherosclerosis as Related to Oxidative Stress, Inflammation and Vascular Function in Twin Astronauts
	Mason, Christopher	Weill Cornell Medical College	The Landscape of DNA and RNA Methylation Before, During, and After Human Space Travel
	Mignot, Emmanuel	Stanford University	HERO Twin Astronaut Study Consortium (TASC): Immunome Changes in Space
	Rana, Brinda	UC, San Diego	Proteomic Assessment of Fluid Shifts and Association with Visual Impairment and Intracranial Pressure in Twin Astronauts
	Snyder, Michael	Stanford University	HERO Twin Astronaut Study Consortium (TASC) Project: Longitudinal Integrated Multi-omics Analysis of the Biomolecular Effects of Space Travel
	Turek, Fred	Northwestern University	HERO Twin Astronaut Study Consortium (TASC) Project: Metagenomic Sequencing of the Bacteriome in GI Tract of Twin Astronauts



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Twins Study – cont.

IN-FLIGHT OPERATIONS

- Cognitive testing:
 - The 1YM USOS crew member and twin will perform
 - **Cognition experiment**
- Physiological measures:
 - The 1YM USOS crew member and twin will perform
 - **Fluid Shifts tests**
 - **Cardio Ox ultrasound scans**



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Twins Study – cont.

IN-FLIGHT OPERATIONS – *Typically performed with sample collection for other HRP studies*

- Frozen blood
 - Blood draw on FD15, 60, 120, 180, 191, 240, 300, and R-14; Centrifuged, then stored in MELFI
 - Includes new glass tubes which require a second level of containment and more space in MELFI
- Frozen urine
 - 24 hour void-by-void collection on FD15, 60, 120 180, 240, 300, and R-14; samples stored in MELFI.
- Ambient blood
 - Blood draw in association with 41S, 43S, and 44S return
 - One glass tube may be spun in centrifuge (ONLY use of centrifuge for ambient blood for ANY STUDY)
 - 72 hr return to Houston, as usual



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Twins Study – cont.

IN-FLIGHT OPERATIONS – *Typically performed with sample collection for other HRP studies*

- Vaccination (flu shot):
 - Flu Shot administered ASAP after the FD180 frozen blood draw.
Another blood draw 11 days (+/-3) later.
 - Vaccine requires refrigeration (2 to 8°C) during launch and while stored on-orbit prior to the vaccination.
- Buccal samples (cheek)
 - FD7, 90, 180, 240, and R-30/1; samples stored in MELFI
 - Uses existing Microbiome swab tubes and Saliva Session Packs.
- Fecal Samples
 - FD7, 90, 180, and R-30; samples stored in MELFI
 - Uses existing Microbiome fecal tubes and performed with Microbiome sessions.



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Acronyms & Abbreviations

BCR	Barcode Reader	MSFC	Marshall Space Flight Center
BDC	Baseline Data Collection	MELFI	Minus Eight Laboratory Freezer for ISS
BP	Blood Pressure	NaBr	Sodium Bromide
DCT	Data Collection Tool	NASA	National Aeronautics and Space Administration
DPC	Daily Planning Conference	OCA	Orbital Communications Adapter
CCFP	Cerebral Cochlear Fluid Pressure	OCT	Optical Coherence Tomography
DPOAE	Distortion Product Otoacoustic Emissions	PC	Portable Computer
ECG	Electrocardiogram	PI	Principal Investigator
EXPRESS	EXpedite the PROcessing of Experiments to Space Station	PODF	Payloads Operations Data File
FD	Flight Day	PFS	Pulmonary Function System
GDS	Gas Delivery System	PSPA	Personal Self Perception and Attitudes
HRF	Human Research Facility	PuFF	Pulmonary Function in Flight
HRP	Human Research Program	PVT	Psychomotor Vigilance Test
ID	Identification	PWD	Portable Water Dispenser
IOC	Intraocular Pressure	R+/-	Return Plus/Minus
IP	Internet Protocol	RC	Refrigerated Centrifuge
ISC	Increment Science Coordinator	RFID	Radio Frequency Identification
ISS	International Space Station	RIC	Rack Interface Controller
ISSMP	International Space Station Medical Project	S/G	Space-to-Ground
JEDI	Joint Execute Package Development & Integration	SODF	Systems Operations Data File
L+/-	Launch Plus/Minus	SSC	Station Support Computer
LAN	Local Area Network	TCD	Trans-Cranial Doppler
		USOS	United States Operating Segment
		USND2	Ultrasound 2 (2 nd generation HRF USND)